

# Asian Monsoon Observed by Spaceborne Scatterometer

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- Interannual changes
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# **Asian Monsoons Observed by Spaceborne Scatterometer**

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Monsoons are the seasonal change of wind forced by continent-ocean temperature contrast. They are the major agents through which land and marine atmospheres interact. Besides bringing rain from the ocean to land, monsoons change ocean currents, ocean upwelling, and coastal ecology. Its annual onset, intensity, and retreat vary greatly, and a large percentage of the world's population and their agrarian economy must endure the vagaries of monsoons. Over land the consequences of monsoon are, perhaps, well observed, but the breeding ground over the ocean has been insufficiently monitored. Spaceborne sensors can play a critical role in monitoring and understanding monsoons.

Using wind vectors derived from spacebased scatterometers, the annual cycles of monsoon in the South China Sea and in the Arabian Sea have been compared. Significant negative correlations between the curl of wind stress derived from scatterometer data and sea level change derived from spacebased altimeter data in the central parts of the both basins are found to be consistent with seasonal changes of Ekman pumping following the monsoons. In the deep basins, positive stress curl causes high sea level and anticyclonic geostrophic currents in summer.

The relation between the Asian monsoons and El Nino Southern Oscillation were also studied with a longer time series constructed by combining various spacebased wind data. The winter composite of La Nino events shows an anomalous cyclonic gyre centers in Philippines. The cyclonic anomalies appear to cause lower sea level and sea surface temperature in the Asian marginal seas, mostly because of the increase of upwelling in the ocean. The upwelling may reduce the zonal temperature and thermocline gradients in the western Pacific, and provide a negative feedback to the La Nino event. The northeast wind anomalies over the South China Sea during winter means a stronger than normal monsoon. The abundant moisture is brought into the basin by the intensified northeasterly from the Philippine Sea and East China Sea where the water is abnormally warm, leading to high moisture supply in the basin, and less than normal latent heat flux, despite strong winds. The cooler SST is caused by ocean dynamics and not by local surface cooling.

## **Objectives**

- Identify distinctive features of seasonal variation of Asian monsoon using spacebased data
- Link interannual variation of Asian monsoon with Pacific SST
- Examine impact of interdecadal change on interannual variation of Asian monsoon

## **DATA**

**ERS, SSM/I & QuikSCAT winds**

Atlas et al. 1996; Liu et al. 1998

**TOPEX/POSEIDON sea level**

Fu et al. 1994

**SSM/I integrated water vapor**

Wentz 1996

**NCEP Optimally Interpolated SST**

Reynolds and Smith 1994

**COADS**

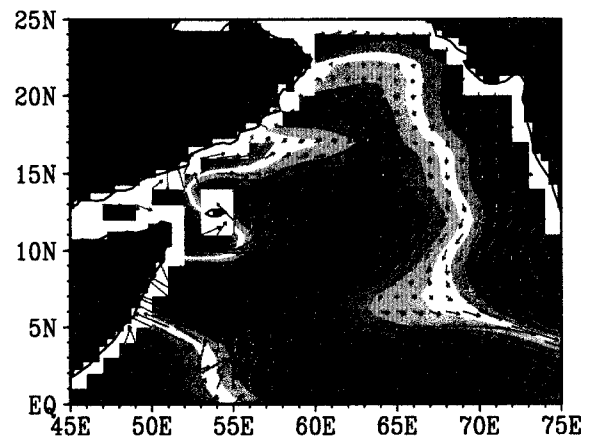
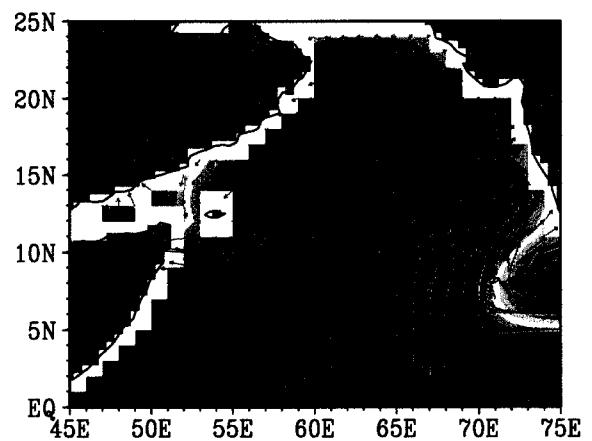
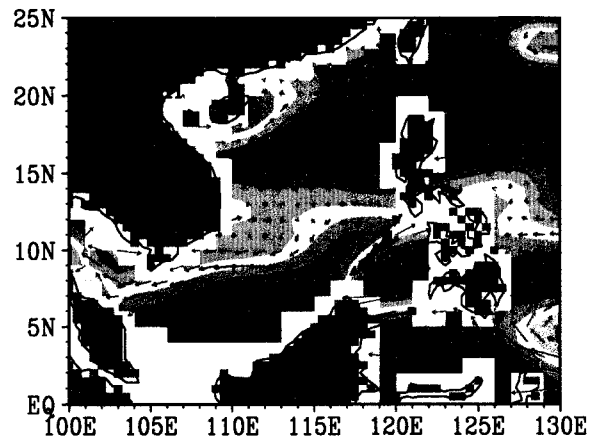
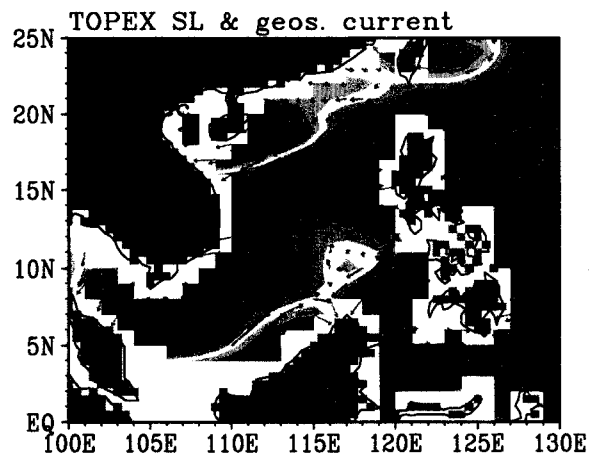
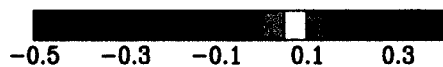
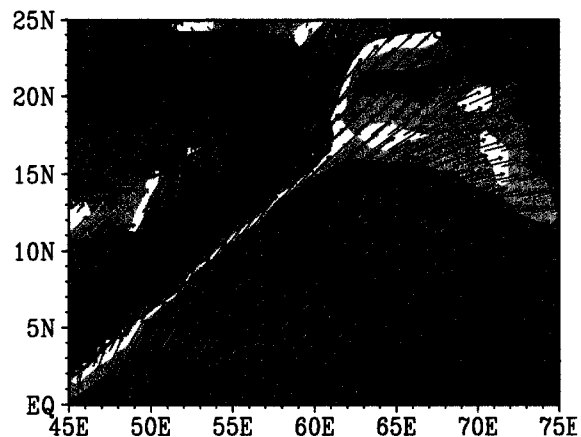
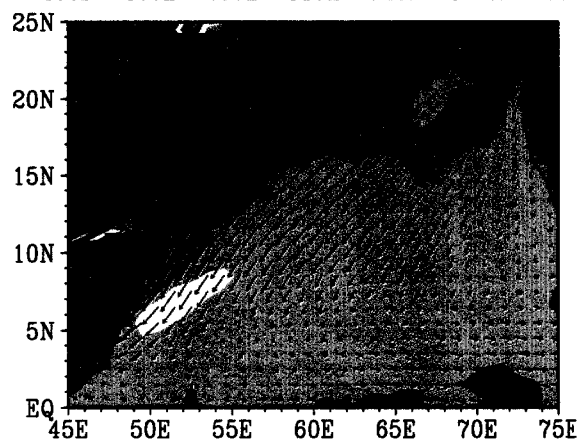
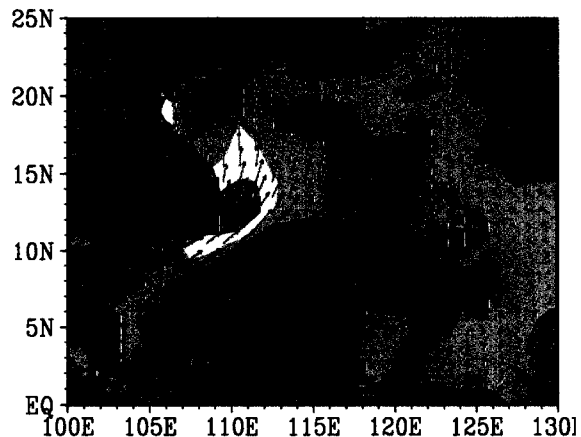
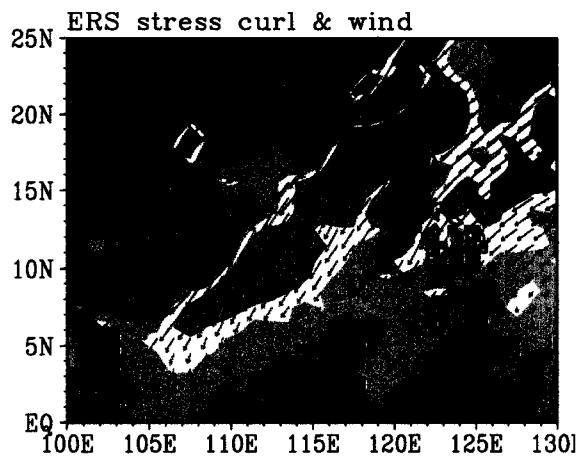
Woodruff et al. 1993

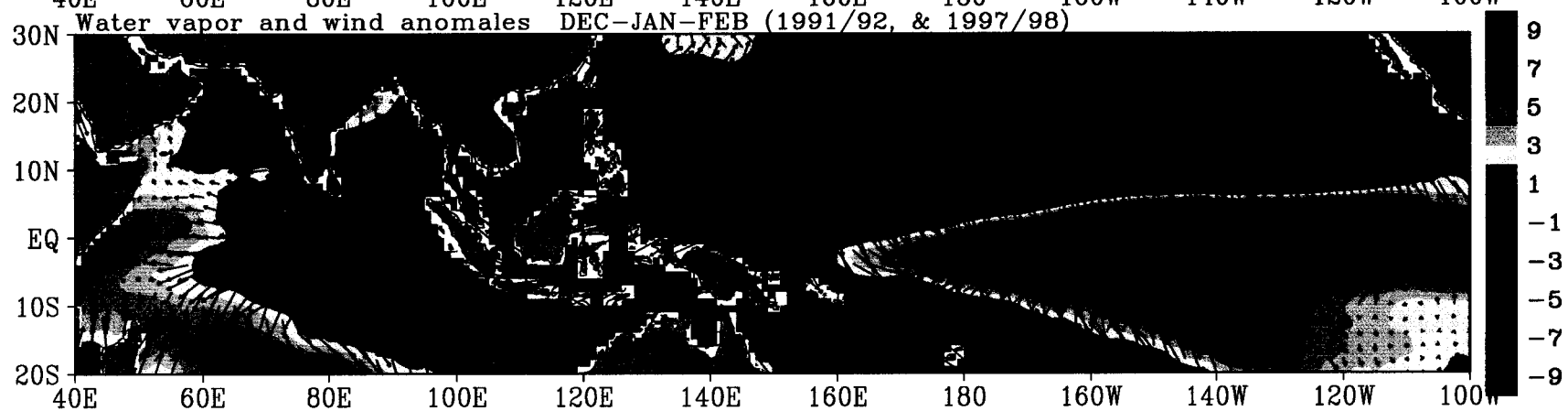
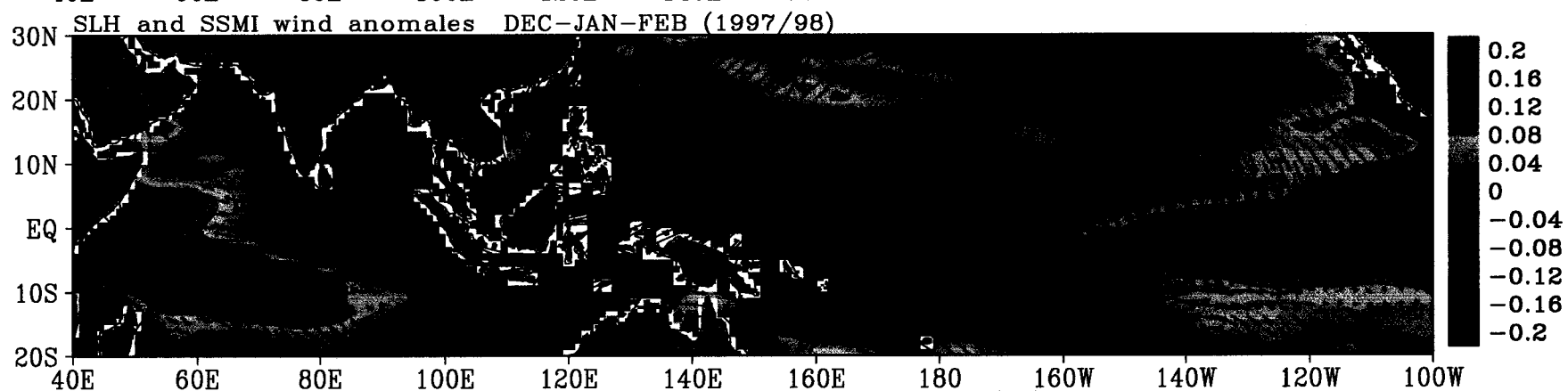
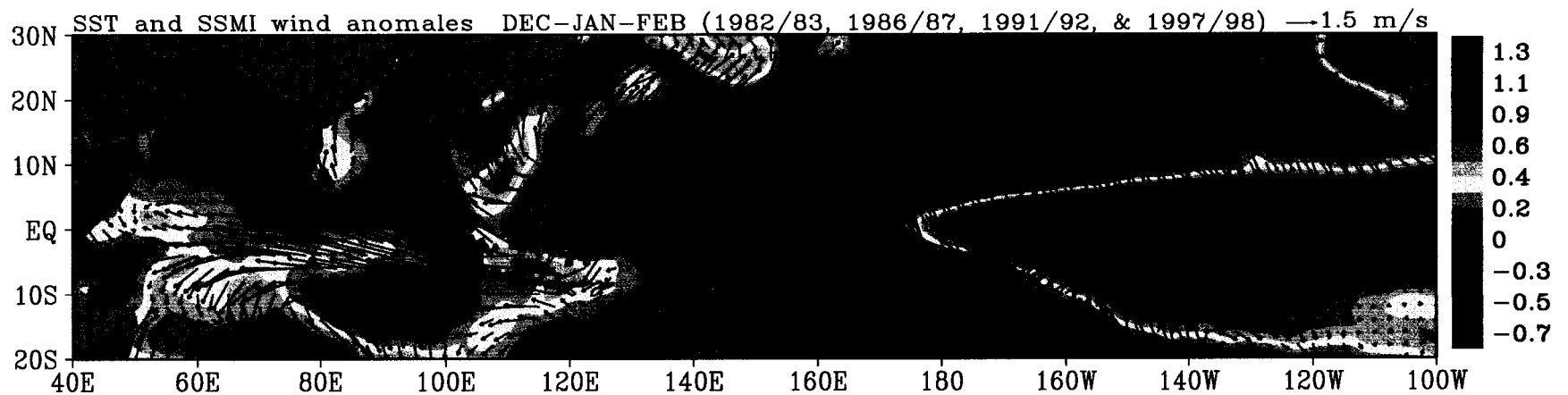
**GISST**

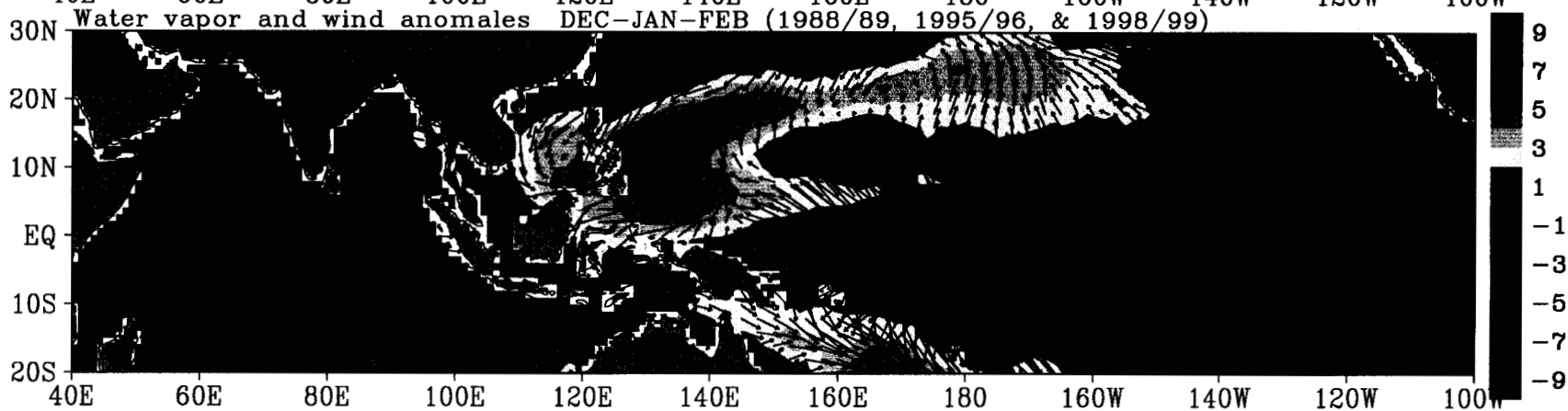
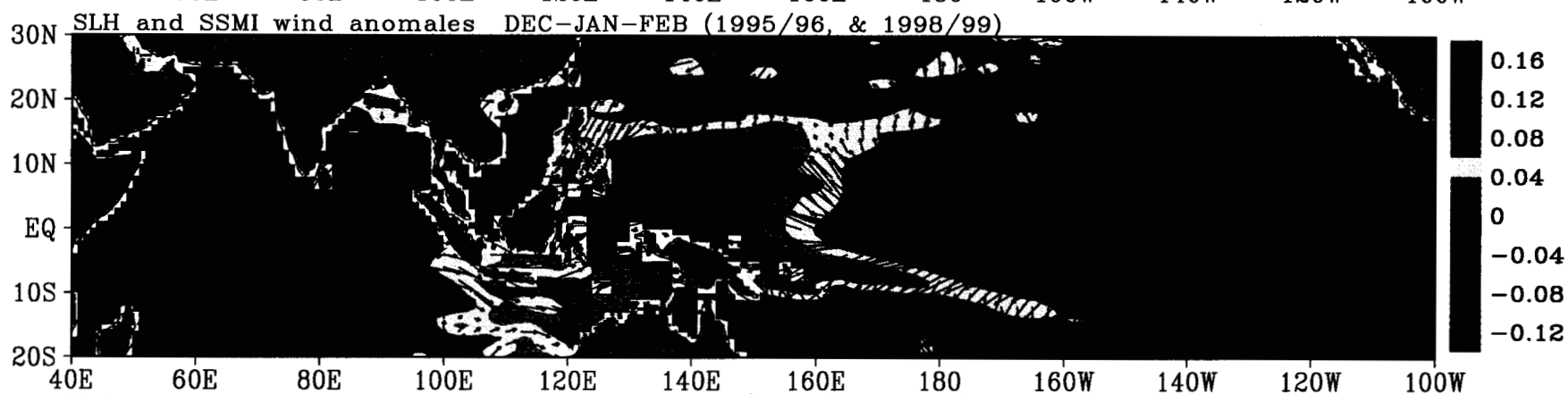
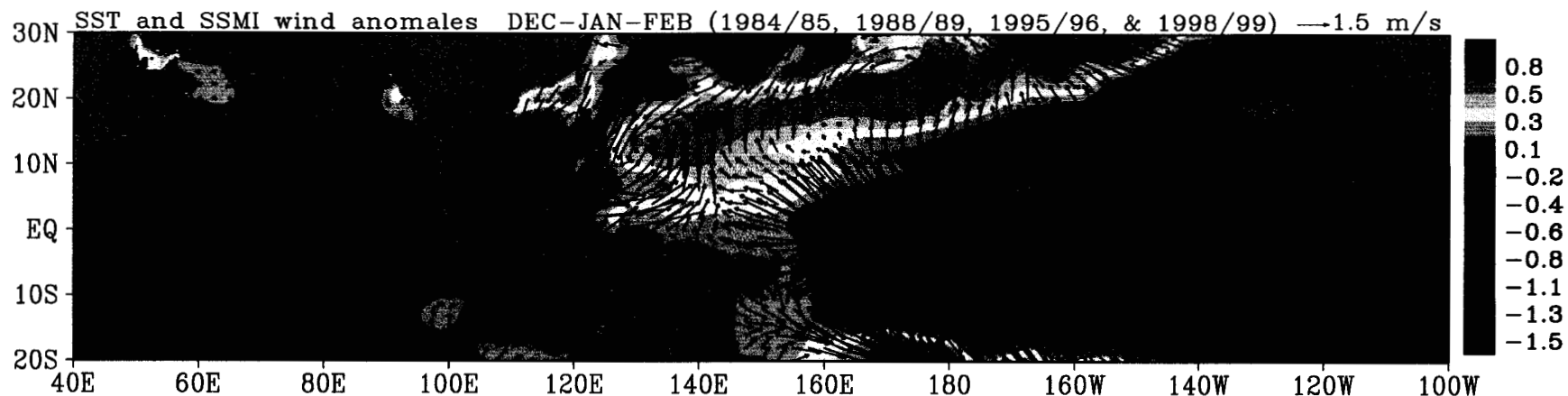
Rayner et al. 1996

## SUMMARY

- Using a combination of spacebased data, the distinctive features of annual and inter-annual variations of Asian monsoon were examined.
- The annual variations of SST and sea level in both South China Sea and Arabian Sea are consistent with the Ekman pumping scenario.
- The interannual variations of East Asian monsoon is closed linked to tropical Pacific SST. Westerly (easterly) anomalies associated with the cyclonic (anticyclonic) anomalies over the Philippines may provide negative feedback to eastern Pacific cooling (warming).
- Indian summer monsoon is weaker (stronger) during Pacific warm (cold) events associated with relatively warm (cold) southern or eastern Indian Ocean. Interdecadal impact is particularly evident during the 1997/98 warm event.

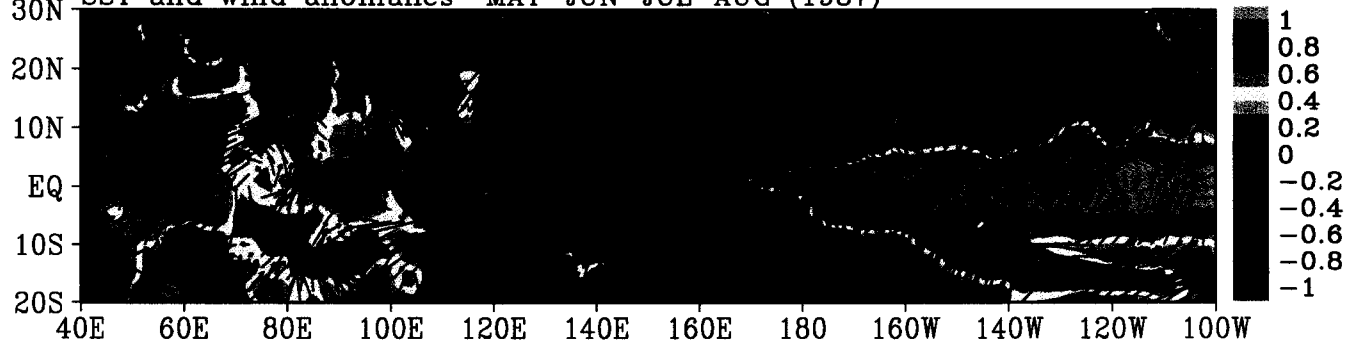




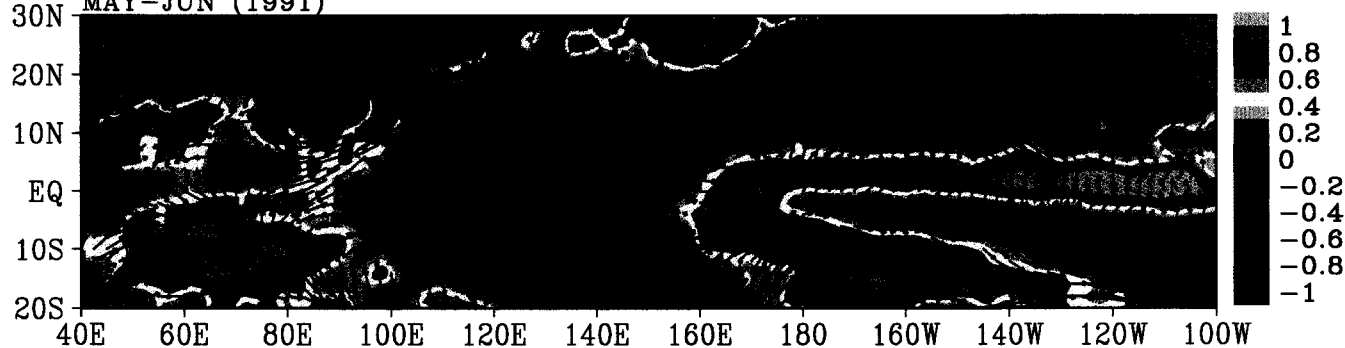




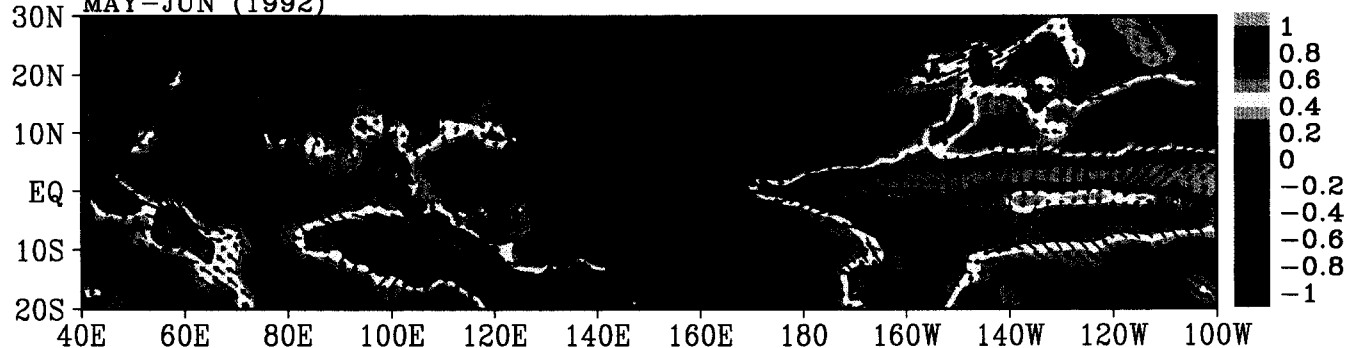
SST and wind anomalies MAY-JUN-JUL-AUG (1987)



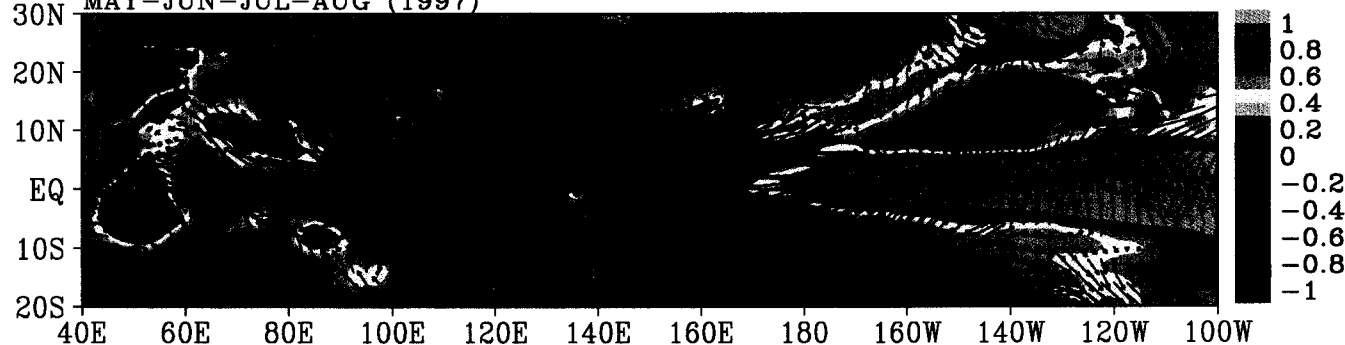
MAY-JUN (1991)



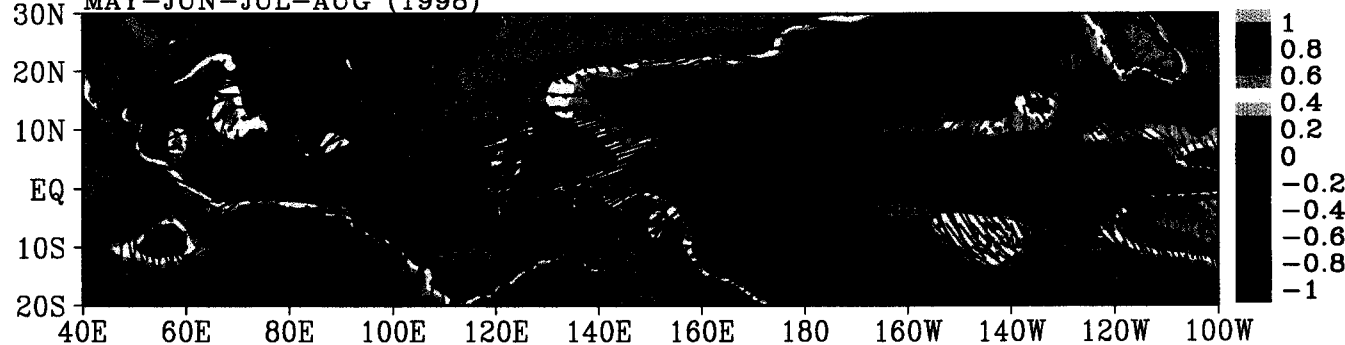
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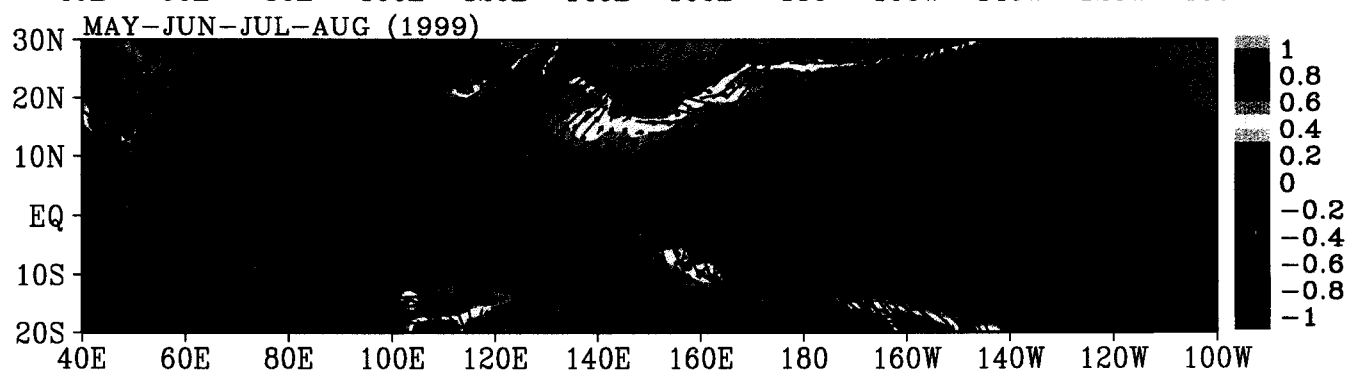
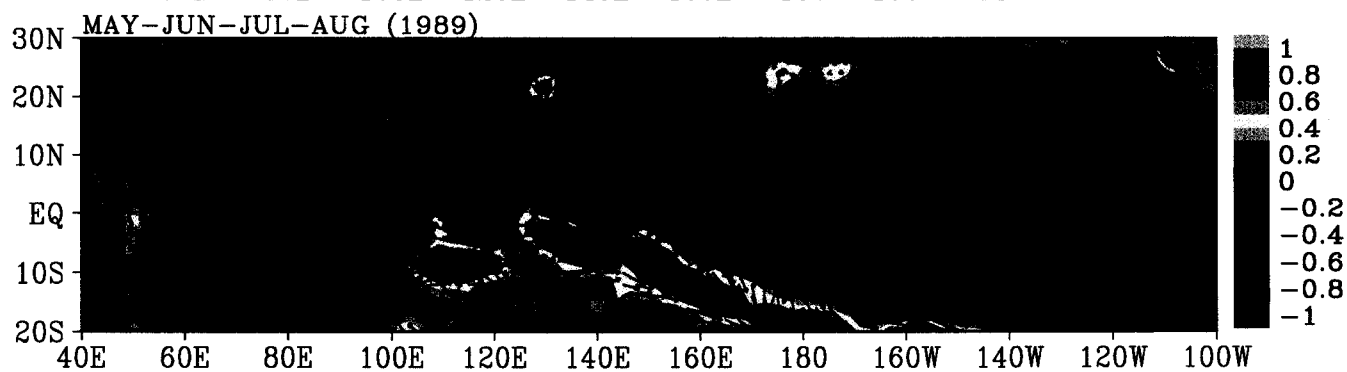
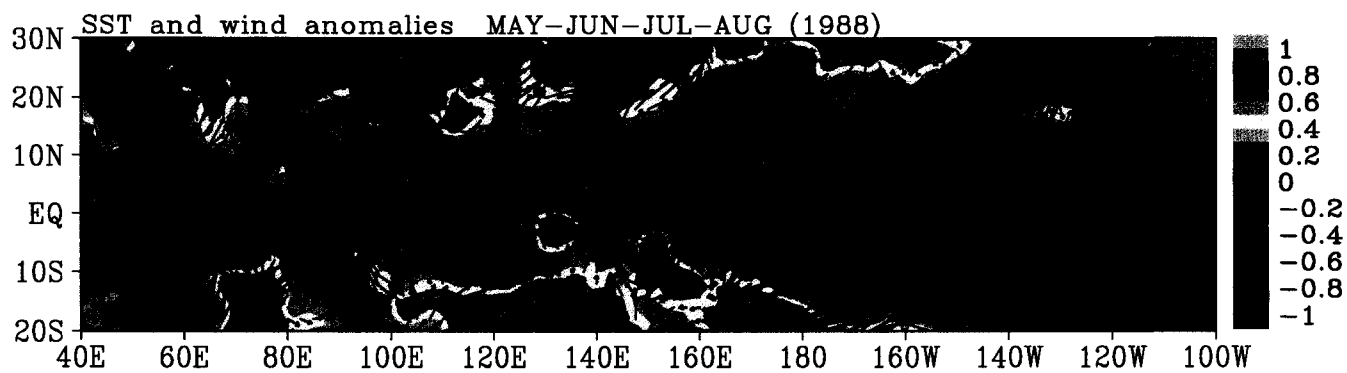


MAY-JUN-JUL-AUG (1997)



MAY-JUN-JUL-AUG (1998)





Interdecadal mode (GISST) at 10N

